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GROUNDWATER GEOLOGY IN EAST-CENTRAL ILLINOIS

A Preliminary Geologic Report

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Service activities concerning groundwater are performed jointly by the Illinois State Geological Survey and the Illinois State Water Survey.

DIVISION OF THE
ILLINOIS STATE GEOLOGICAL SURVEY
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CIRCULAR 248 1958

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ABSTRACT

Probabilities for developing domestic, farm, municipal, industrial, and irrigation groundwater supplies in central Illinois range from poor to excellent. This report presents a general summary of groundwater principles, summarizes the geologic factors that control the availability of groundwater, and discusses methods of developing groundwater supplies.

The maps show 1) probability of occurrence of sand and gravel aquifers; and 2) areal distribution, type, and water-yielding character of upper bedrock formations.

INTRODUCTION

This report is the last of a series of Circulars which have been prepared by the Illinois State Geological Survey to describe and outline groundwater conditions throughout the State.* The aim of these studies is to provide the public with general information on groundwater principles and with regional information on groundwater availability. This report supplements Circular 192, "Water Wells for Farm Supply in Central and Eastern Illinois," by providing more detailed examination of available data and including evaluation of groundwater probabilities for municipal and industrial supplies as well as for domestic and farm needs.

The region described is Agriculture Extension District No. 3, which includes the following counties: Champaign, Christian, Coles, DeWitt, Douglas, Edgar, Ford, Iroquois, Livingston, Logan, McLean, Macon, Marshall, Mason, Menard, Moultrie, Piatt, Putnam, Sangamon, Tazewell, Vermilion, and Woodford (figs. 1, 3). It comprises 13,852 square miles and has a population of about 920,500. It includes a large area of highly productive agricultural land on which general farming is the principal enterprise.

Water is essential to an expanding economy. The location of new industries, the growth of communities, and any forms of land improvement are controlled by the water resources of an area. The purpose of this report is to provide information on the availability of groundwater for farm, industrial, and municipal supplies. It discusses principles of groundwater occurrence and development and describes basic methods of well construction.

Although the Illinois, Sangamon, and Embarrass rivers provide large quantities of surface water, most of the water supplies utilized directly or indirectly by man in the area come from the much larger subsurface reservoir in the ground. Subsurface water is stored either in the soil zone as soil moisture, where it is available for the growth of plant life, or in the underlying zone of permanent saturation as groundwater, from which it is withdrawn for use by springs and wells. Groundwater is the major source of water supply for farms, cities, and

* Previous reports in the series (see fig. 1), listed in "Suggested Reading" on page 35, are available upon request from the Survey offices in Urbana, Illinois.

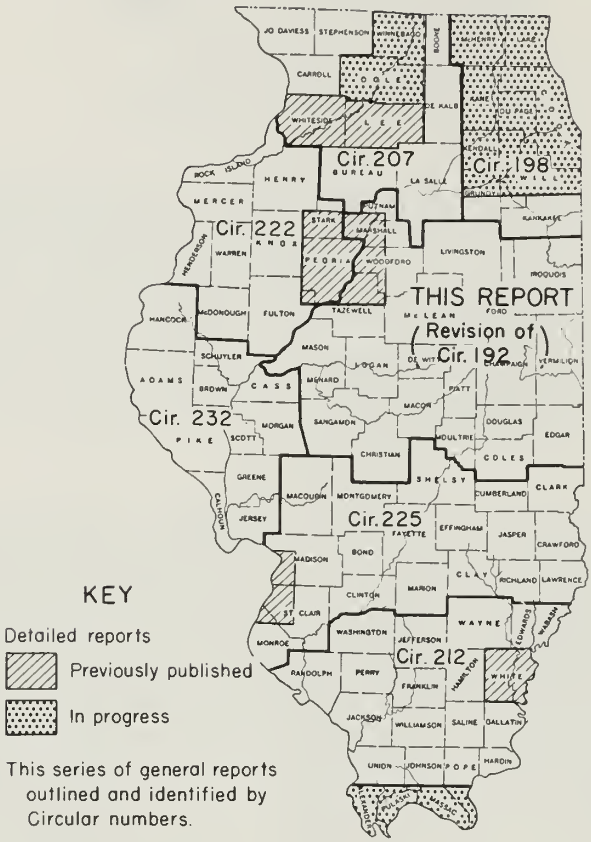


Fig. 1. - Index map to reports on groundwater geology in Illinois published since 1950 or in progress.

industries in the region covered by this report. The demand for groundwater is great because surface water supplies are not always present where needed, and even where present they commonly require considerable capital outlay for collection and treatment.

The availability, quantity, and quality of groundwater depend upon the nature and arrangement of the earth materials beneath the surface, that is, upon geological conditions. Any groundwater supply, whether for small domestic needs or for the large requirements of a city or industry, can be obtained only where geologic formations that can transmit water are present. Formations that transmit water are said to be permeable and are called aquifers. Because geologic conditions differ from place to place, groundwater is readily available in some areas whereas in others it is difficult to obtain. The proper development of the groundwater resources of an area, therefore, is greatly assisted by information on the distribution and character of the aquifers that may be present.

The authors wish to acknowledge the helpful assistance given by drilling contractors in providing large numbers of logs of water wells in central Illinois and in supplying information on specific problems of occurrence of water-yielding materials and drilling conditions. We also acknowledge the assistance given by Paul Hughes and other members of the Groundwater Section and of other Sections of the State Geological Survey. The data on water quality and well yields contained in this report have been taken from records or published reports of the Illinois State Water Survey.

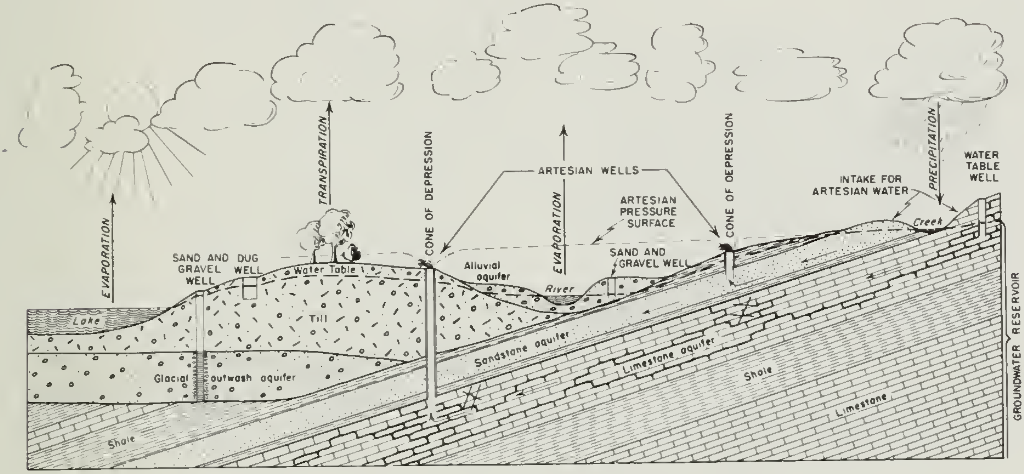


Fig. 2. - Source, movement, and occurrence of groundwater.

OCCURRENCE OF GROUNDWATER

Because groundwater occurs beneath the earth, hidden from view, it is often regarded as somewhat mysterious, and throughout human history many fanciful explanations have been presented to describe its source, movement, and occurrence. Scientific study has shown, however, that groundwater obeys physical laws or principles that are relatively simple and easily understood, although they may be complex in detail. Figure 2 shows diagrammatically the basic fundamentals of our present understanding of the source, movement, and occurrence of groundwater.

The source of groundwater is seepage into the earth of some of the moisture that falls as rain, snow, and ice. The tremendous quantity of water that falls on the land surface by precipitation is seldom fully realized; one inch of rainfall distributed over one square mile amounts to nearly 18 million gallons. However, only a small part of the precipitation actually enters the groundwater reservoir. Most of it falls into lakes and oceans, runs off in streams, or is returned to the atmosphere by evaporation and transpiration. The remainder filters slowly into the ground to a level below which all available openings are filled with water.

The top of this zone of saturation is called the water table. Under water-table conditions, a well drilled or dug remains dry until it penetrates the zone of saturation; the position of the water table is then shown by the level at which water stands in the well. The water table is not level but conforms more or less to the features of the land surface. Where the water table intersects the land surface, groundwater is discharged in the form of springs which feed perennial streams, lakes, and swamps. The water table rises or falls in response to the gain or loss of groundwater in the reservoir, so the water level in a well that

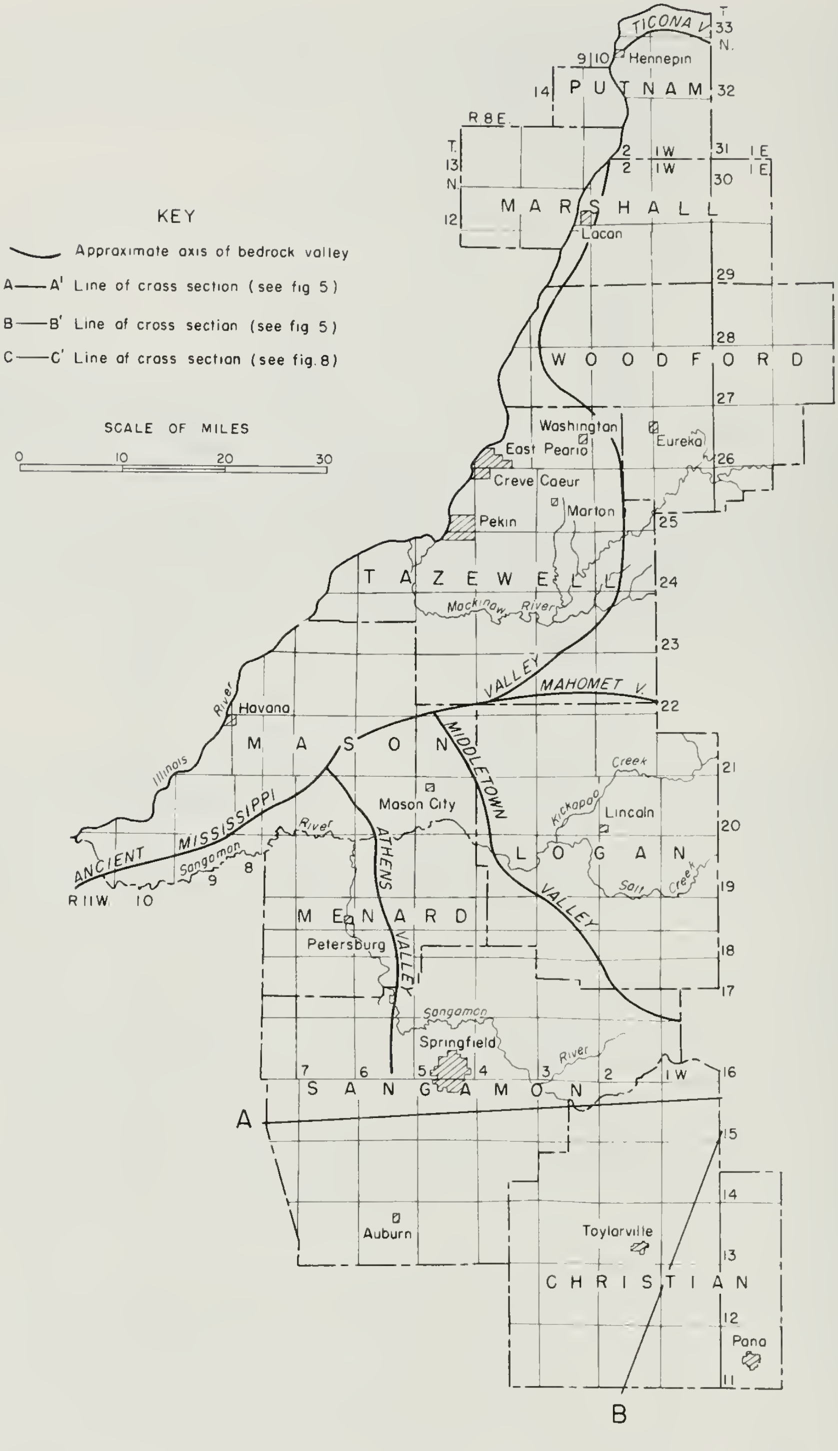
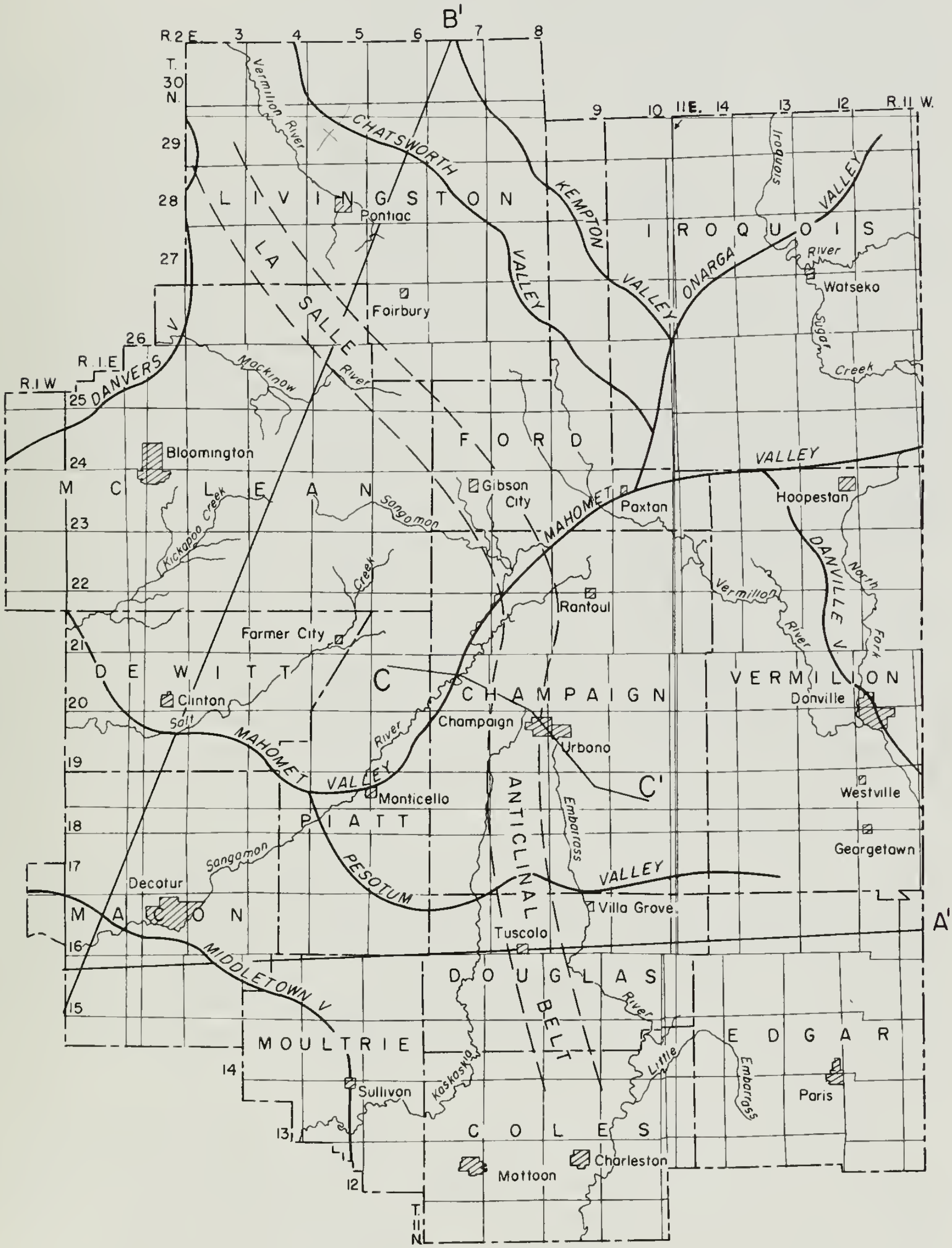


Fig. 3. - East-central Illinois, showing major bedrock



valleys, LaSalle anticlinal belt, and lines of cross section penetrates the saturated zone (a "water-table" well) rises or falls with the water table. During extended dry periods shallow wells go dry when the water table drops below the bottom of the well.

Groundwater moves, under the influence of gravity or in response to other pressure differentials, toward points of lower pressure, such as springs or discharging wells. The movement is slow because of friction between water and the walls of the small pores or other openings in the rocks. Under such conditions groundwater moves slowly by gravity flow in the direction of the slope of the water table.

Groundwater is said to be confined or under artesian conditions where a saturated aquifer is overlain by a less permeable material that restricts the upward movement of the water. Under such conditions the water in the confined layer has a hydrostatic pressure that causes the water in a well to rise above the top of the aquifer. Where pressures sufficient to cause the water to rise above the land surface are encountered in an artesian well, the well will flow.

To supply a pumped or flowing well, groundwater must move through the aquifer toward the well. Under water-table conditions, pumping lowers the water table in the vicinity of the well and gravity induces groundwater to flow toward the well from adjacent areas. Under artesian conditions, pumping reduces the hydrostatic pressure in the vicinity of the well, and induces the flow of groundwater toward the well. The depression in the water table, or in the artesian pressure surface resulting from discharge, is in the form of an inverted cone with the well at the center and is called the cone of depression (fig. 2).

Water is to be found everywhere below the top of the zone of saturation, but successful wells can be constructed only where strata that will transmit water easily are present. The capacity of earth materials to accept, store, and yield water depends on the type, size, number, and degree of interconnections that can store and conduct groundwater. Sand and gravel aquifers store considerable water and transmit it readily. Other earth materials, such as clay and shale, may contain as much or more water per cubic foot as sand and gravel, but they hold water in pores so small that it cannot be transmitted in usable quantities to wells.

Sand and gravel deposits are water-yielding because the openings between the grains are large enough to allow relatively free movement of water. The most permeable water-yielding sand or gravel deposits are composed of grains that are nearly all the same size and coarser than granulated sugar. If large amounts of silt and clay are present in the spaces between the larger particles of sand and gravel they retard the flow of water. Sand and gravel deposits in the area of this report are from a few inches to about 200 feet thick. Deposits a few feet or more thick are generally suitable aquifers for drilled wells. Thinner deposits of sand and gravel may be suitable only for large-diameter dug or augered wells.

Sandstone formations also transmit groundwater through the openings between sand grains. The water-yielding capacity of sandstone depends upon the degree of cementation, size, and sorting of the sand grains. Any material in the openings between the sand grains reduces the water-transmitting capacity of the sandstone. Some sandstones are so thoroughly cemented that any water present moves through joints and fractures rather than between grains.

Relatively few wells have been completed in sandstone in the area of this report. Locally, however, the St. Peter sandstone of Ordovician age and thin

SYSTEM	SERIES OR GROUP	FORMATION THICKNESS (FT.)	GRAPHIC LOG	ROCK TYPE (DRILLERS TERMS)	WATER-YIELDING CHARACTERISTICS; DRILLING AND WELL CONSTRUCTION DETAILS
	Pleistocene	0-500		Unconsolidated glacial deposits, alluvium and wind-blown silt (drift, surface, overburden)	Water-yielding character variable. Large yields from thicker sand and gravel deposits in bedrock valleys. Wells usually require screens and careful development. Chief aquifer in area
PENNSYLVANIAN	McLeansboro	0-1000		Mainly shale with thin limestone, sandstone and coal beds (Coal Measures)	Water-yielding character variable. Locally shallow sandstone and creviced limestone yield small supplies. Water quality usually becomes poorer with increasing depth. May require casing
	Carbondale	0-150			
	Tradewater Caseyville	0-600			
MISSISSIPPIAN	Chester	0-500		Limestone, sandstone and shale	To deep to be considered as a source of groundwater in this area
	Valmeyer	Ste. Genevieve 0-120		Limestone	May be water-yielding in Mason county where these formations are present at a shallow depth. In the rest of the area too deep to be considered as a source of groundwater
		St Louis - Salem 0-270		Limestone	
		Warsaw 0-130		Shale	
		Keokuk - Burlington 0-300		Cherty limestone	
DEVONIAN	Kinderhook	0-200		Shale	Not water-yielding
		0-70		Limestone	Water-yielding from crevices where encountered at a shallow depth. In most of the area too deep to be considered as a source of groundwater
SILURIAN	Niagaran	0-350		Dolomite and limestone	
	Alexandrian	0-100			
ORDOVICIAN	Cincinnatian	Maquoketa 0-200		Shale with limestone and dolomite beds	Not water-yielding at most places; casing required
	Mohawkian	Galena-Platteville 300-430		Limestone and dolomite	Not important as aquifers. Creviced dolomite probably yields some water to wells drilled into underlying sandstone
	Chazy	Glenwood - St. Peter 150 - 300		Sandstone, clean, white, thin dolomite and shale at top (St. Peter)	Dependable source of groundwater in the northern part of the area. Water becomes highly mineralized with increasing depth
	Prairie Du Chien	Shakopee 200-410		Cherty dolomite thin beds of sandstone	Not important as aquifer. Liners in lower St Peter sandstone are commonly seated in upper part of Shakopee
		New Richmond 0-175		Sandstone and dolomite	Not important as aquifers in this area
		Oneota 300-500		Dolomite with some sandstone beds (Lower magnesian)	
CAMBRIAN	St Croixan	Trempealeau 200-250		Dolomite with some sandstone beds	Limestone and sandstone beds are water-yielding. Water highly mineralized or "brine" in most of the area. In the northern part, quality of water unknown
		Franconia 100-200		Sandstone, shale and dolomite	
		Ironton - Galesville 125 - 215		Sandstone, clean, white, thin dolomite bed at the top (Dresbach)	
		Eau Claire 350-500		Shale, dolomite and sandstone	
		Mt. Simon 1200 +		Sandstone, with thin red shale beds	
PRE-CAMBRIAN				Granite and other	Crystalline rocks extending to great depths

Fig. 4. - Generalized column of rock formations in east-central Illinois.

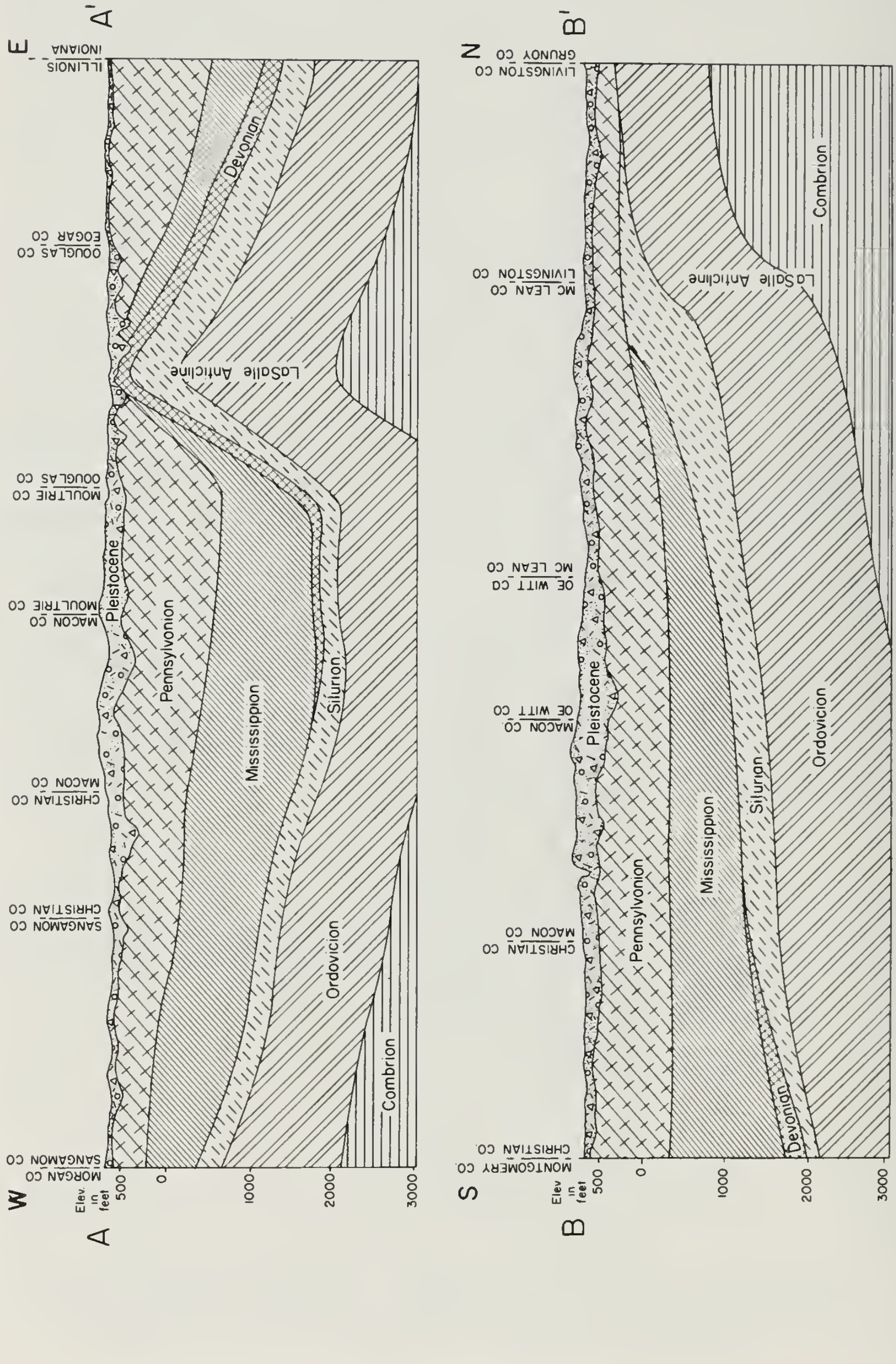


Fig. 5. - Cross sections of formations from west to east and from south to north in east-central Illinois (see fig. 3).

fine-grained Pennsylvanian sandstones are groundwater sources (figs. 4, 5, and 7).

Limestone and dolomite rocks are generally tight and compact, and groundwater moves only through cracks and solution channels. Wells drilled into these rocks are successful if the well penetrates water-bearing crevices. The presence and extent of these openings at any specific location are not readily predictable. The Niagaran-Alexandrian dolomite (Silurian) is a source of groundwater in the northern part of the area where the dolomite is encountered at a shallow depth.

Silurian and Devonian dolomite and limestone are the source of groundwater along the LaSalle anticlinal belt, where present below the drift (figs. 4, 5, and 7).

GEOLOGY

The bedrock formations in east-central Illinois (fig. 4) are layers of sandstone, limestone, dolomite, shale, and coal, arranged one above the other like the pages of a book. The rocks, now firm and compact, were originally deposited as unconsolidated sediments in coastal marshes or in shallow seas that repeatedly invaded the continent. The shale was originally deposited as clay; the sandstone was deposited as sand; the limestone was formed by precipitation of carbonates and by accumulation of sea shells on the sea floor; the coal was formed from plants which were buried in the coastal swamps.

The sedimentary layers, hardened into rock, were later warped and tilted so that today they are no longer horizontal. In east-central Illinois the beds dip eastward and southward to form part of a saucer-like structure known as the Illinois basin. Rocks that are near the surface in Livingston County are encountered at depths of more than 2000 feet in Macon County, and rocks that are near the surface in Mason County are encountered at depths of more than 1000 feet in Macon County (fig. 5). In the eastern part of the basin is a narrow band along which the rocks have been warped upward into arch-like structures called anticlines (figs. 3, 5). This feature, the LaSalle anticlinal belt, extends from Ogle County southeast to Wabash County (fig. 1). Along this belt in east-central Illinois some of the formations which in the basin are too deep to yield potable groundwater are near the surface and are locally important groundwater sources (figs. 4, 5, and 7).

After the Pennsylvanian sediments were deposited, the seas retreated and the upper part of the bedrock was deeply eroded. Then, during the Pleistocene epoch, great continental glaciers advanced from Canada, overriding the eroded bedrock surface and leaving widespread glacial deposits whose nature and distribution are important factors in the occurrence of groundwater in east-central Illinois (fig. 8).

A map of the bedrock surface that lies below the glacial drift shows that a well integrated drainage system was developed on the bedrock surface before the continental glaciers advanced (Bedrock Topography of Illinois, Bull. 73). One of the major valleys of the old drainage system extends across the central part of the State from the Indiana border to the Illinois River valley. This valley takes its name from the village of Mahomet located over the deepest part of the channel in Champaign County (fig. 8). It has been suggested that the ancient river had its source in the Blue Ridge Mountains in North Carolina, flowed northward into Ohio, then west across Indiana and central Illinois, and discharged into the ancient Mississippi River in Mason County. The valley of the Mahomet River and its tributaries, and much of the ancient Mississippi Valley, were completely buried by the deposits of the great glaciers that covered much of Illinois during the Pleistocene epoch. South of Putnam County, the valley of the ancient Mississippi River is now occupied by the Illinois River.

Glacial ice sheets that advanced outward from centers of snow accumulation in Canada transported a great volume of rock debris and in melting deposited it as an irregular blanket that covered the eroded layered bedrock. Till - an unsorted mixture of clay, silt, sand, and pebbles - was laid down under the advancing ice or dumped during its melting.

Beyond the ice front, sediment-laden meltwaters flowed down valleys, partially filling them with deposits of outwash that consisted of sorted sand, gravel, and finer material. River flats, kept free of vegetation by frequent glacial flooding, were subject to wind erosion, and great volumes of silt were blown into the uplands bordering the valleys to form loess deposits. Till, outwash, loess, and the sediments of modern streams now cover the bedrock surface of east-central Illinois, resulting in a relatively level plain. This plain is broken by broad ridges (moraines) that were deposited along the ice front in a roughly concentric pattern (fig. 8).

There were four major glaciations - Nebraskan, Kansan, Illinoian, and Wisconsin - but glaciers of only the last three are known to have entered the area of this report. Each glaciation was followed by an interglacial period in which the climate warmed and the ice front melted back. The advance of each glacial lobe greatly modified the drainage of east-central Illinois. The Mahomet River Valley and its tributaries were gradually filled, the course of the Mississippi River was diverted westward to its present position, and the Illinois River became the major stream in the area. These changes in the drainage system were very complex.

The character of the glacial deposits encountered in drilling shows that the valleys were filled at intermittent periods. Sand deposits as much as 200 feet thick are found in the deepest part of the valleys. It is believed that they were deposited before or during the advance of the earliest ice sheet when the old valleys were the main drainage system. The deposits in the ancient Mississippi River Valley in the Peoria region are called "Sankoty sand," and those in the Mahomet Valley (Bulletin 73, Bedrock topography of Illinois) have been called "Mahomet sand." The sand deposits are an important source of groundwater (see county summaries). The later advance of the Kansan, Illinoian, and Wisconsin glaciers completed the filling of the valleys with till interbedded locally with sand and gravel.

DISTRIBUTION OF AQUIFERS

Sand and gravel deposits are the most important aquifers along the courses of streams and in the fill of buried valleys. They are also important sources of groundwater in areas where the glacial drift is thick. Figure 6 shows the probability of occurrence of sand and gravel aquifers. The areas shown as "good to excellent" are underlain by thick deposits of unconsolidated material containing sand and gravel aquifers. Groundwater for domestic and farm supplies may be obtained readily from this material with small-diameter drilled wells. The probabilities for construction of high-capacity wells for industries and municipalities are good, although test drilling is necessary to locate suitable sand and gravel deposits.

The areas shown as "fair to good" in figure 6 are underlain by moderate thicknesses of unconsolidated materials that fill shallow valleys or lie on the uplands bordering the main valleys. These materials contain thin and discontinuous deposits of sand and gravel. Groundwater for domestic and farm supplies is obtained locally in this area from wells drilled in sand and gravel, but in some places good water-yielding deposits are absent and water from the unconsolidated material is obtainable only with large-diameter dug wells. The probabilities of obtaining supplies of water for industrial and municipal purposes are poor to fair. Extensive test drilling generally is necessary to locate water-yielding deposits.

The areas outlined by dashes in figure 6 correspond to buried bedrock valleys that contain deposits of unconsolidated material as much as 150 to 200 feet thick. Few well records are available in these areas and therefore the presence and extent of sand and gravel deposits is not known. The areas, however, merit special attention in exploration for water-yielding sand and gravel.

The areas shown as "poor" are primarily bedrock upland. Glacial deposits, if present, are thin or are composed mainly of tight till. Sand or gravel deposits which might supply groundwater are rare and most wells obtain water from the bedrock.

Figure 7 shows the distribution and water-yielding character of the bedrock formations that crop out at the surface or lie directly beneath the glacial and alluvial material.

The Pennsylvanian bedrock, encountered below the drift in most parts of the area, generally is not a reliable source of groundwater. Locally, however, domestic and farm supplies are obtained from creviced limestone, permeable sandstone, or cracked shale and coal in the upper part of the Pennsylvanian bedrock. Throughout east-central Illinois wherever water can not be obtained from the unconsolidated material, and where there are no other usable bedrock aquifers, the upper part of the Pennsylvanian bedrock should be tested.

Silurian and Devonian limestone and dolomite are suitable sources of groundwater for domestic and farm supplies where they are present just below the unconsolidated material or where they are thinly covered by Pennsylvanian formations. Locally Silurian dolomite may yield large quantities of water.

In the northern part of the area, municipal and industrial supplies are obtained locally from the St. Peter sandstone. This formation is encountered at depths ranging from 450 feet below land surface in the extreme northwestern corner of Livingston County to more than 2000 feet below land surface in the southern part of the area. In Iroquois, Livingston, Woodford, Marshall, and Putnam counties, a few wells have penetrated this formation (see county summaries). South of the line shown on figure 7, we do not have records of any well finished in the St. Peter sandstone or deeper formations. The quality of water in the St. Peter sandstone becomes poorer toward the south, and in most of the area the water in the St. Peter sandstone is too salty for use.

Only one well, the Chenoa City Well No. 1, has penetrated formations deeper than the St. Peter sandstone. This well was finished at a depth of 2035 feet in the Oneota dolomite (Ordovician).

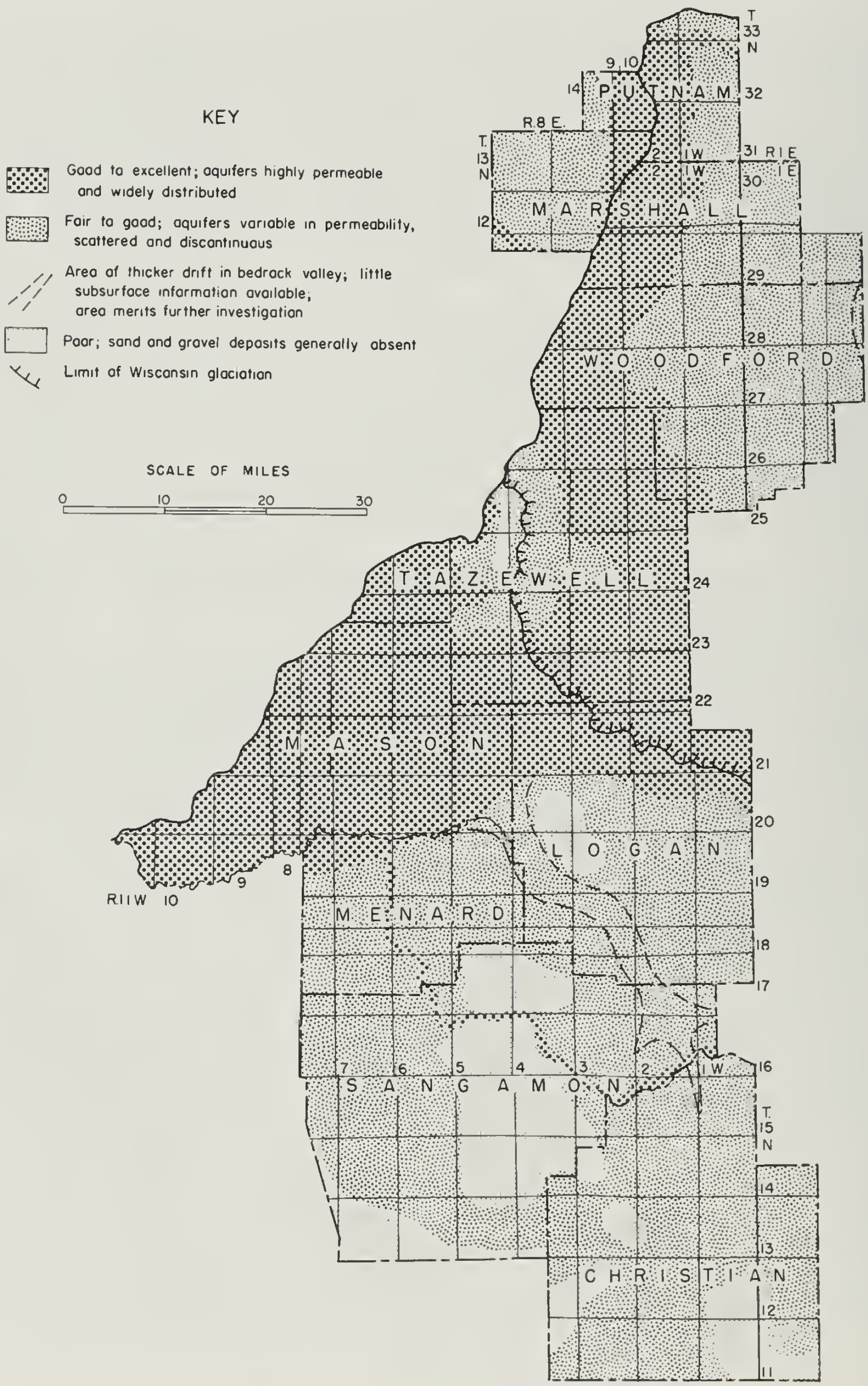
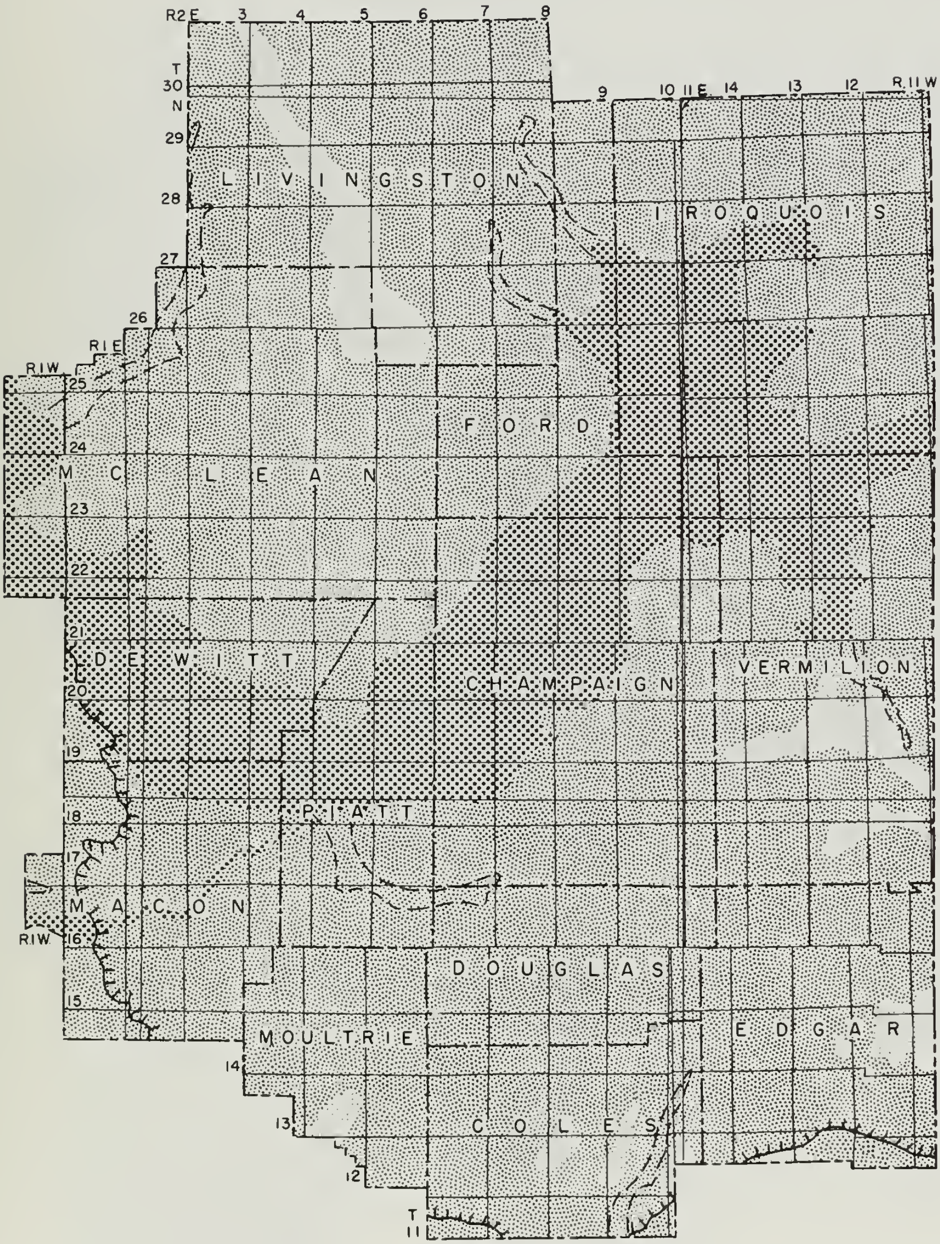


Fig. 6. - Probability of occurrence



and nature of sand and gravel aquifers.

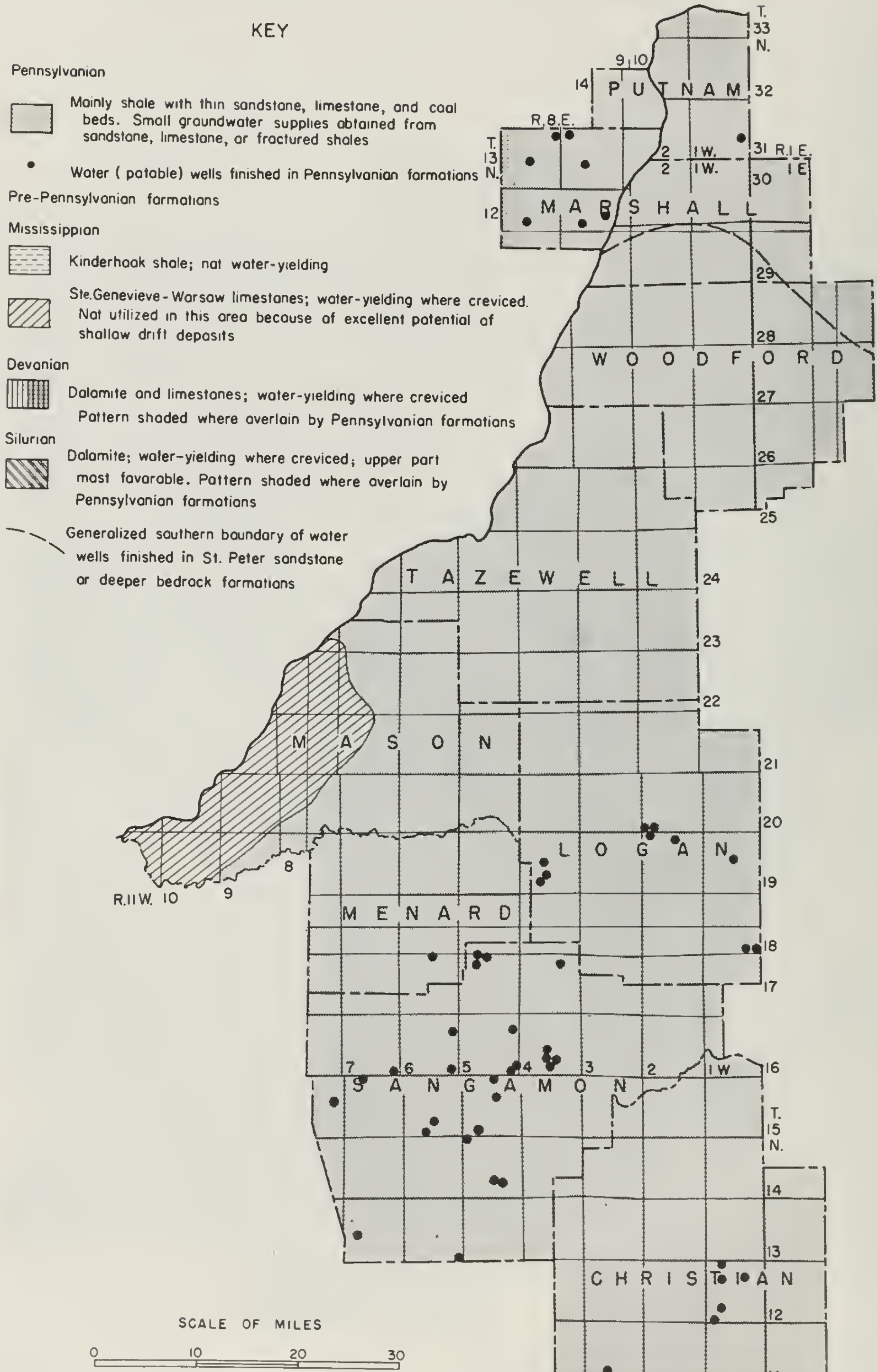
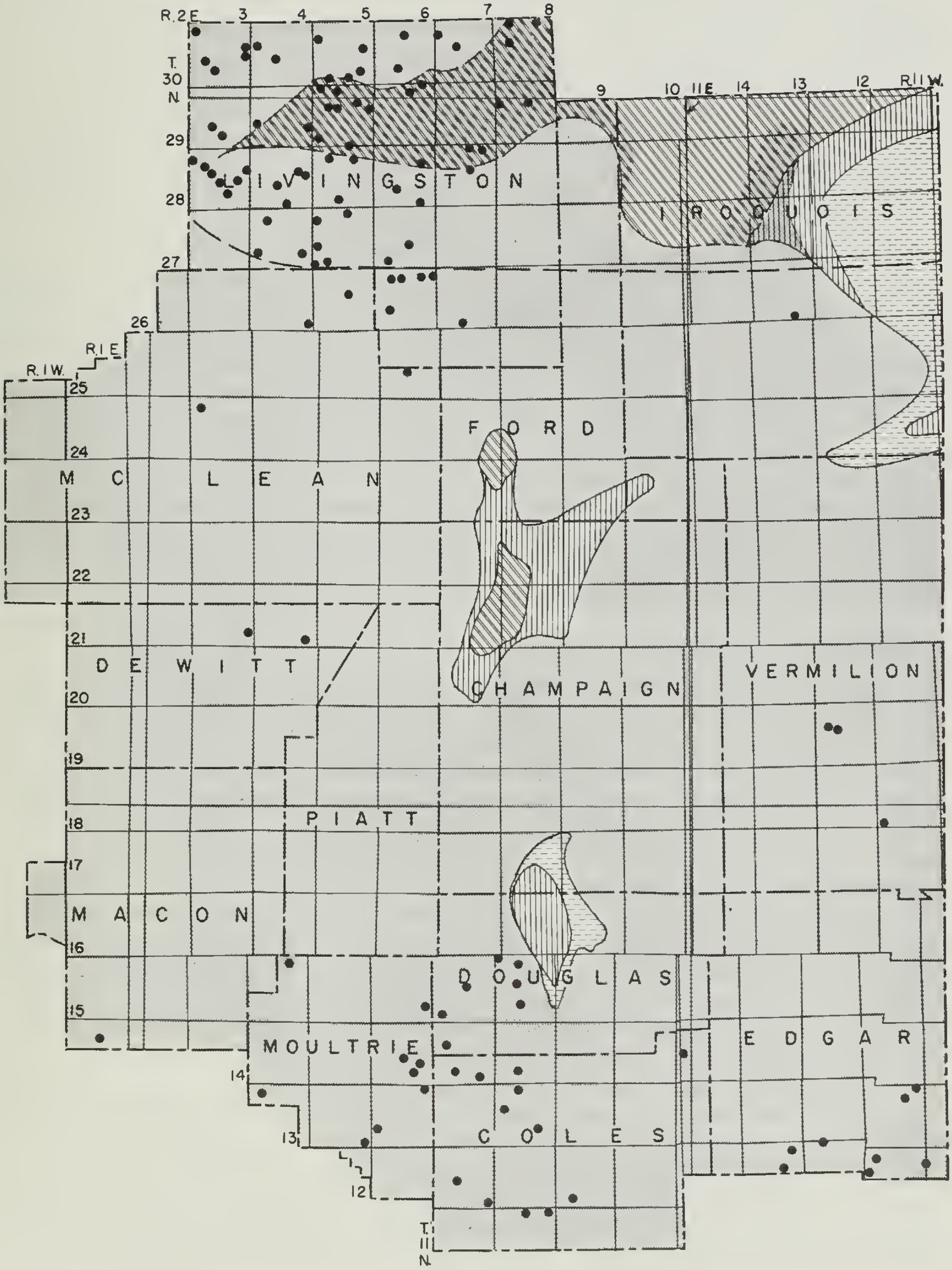


Fig. 7. - Areal distribution, type, and water-yielding character of upper



bedrock formations. (Modified from Geologic Map of Illinois, 1945 ed.)

DEVELOPMENT OF GROUNDWATER SUPPLIES

Geologic Conditions That Affect Groundwater Development

The geologic factors that control the amount and quantity of groundwater available in an area and that must be considered in developing groundwater supplies are:

1) Distribution, depth, thickness, and areal extent of aquifers.
2) Nature of aquifers, including type of materials, kind of openings (pores or crevices), and presence of substances that affect water quality.
3) Geologic structure, including regional and local dips of bed, faults, and jointing.
4) Distribution and nature of relatively impermeable materials.

The presence of an aquifer in a given area does not guarantee a satisfactory groundwater supply. Care must be taken to select the aquifer most suitable for the water supply required, to adapt the type and manner of construction of the well to the geologic conditions, and to place the well where it will best maintain the required standards of quality and quantity of water.

Information on regional geologic conditions pertaining to groundwater supplies at prospective well locations is available upon request from the Illinois Geological Survey. The Survey maintains a current file of subsurface information, including drillers' logs, samples of drill cuttings, and geophysical records from which specific data on formation characteristics for many areas in Illinois are available. Information on well yields, water levels, and water quality is furnished by the State Water Survey.

Unconsolidated Deposits

Where extensive water-yielding sand and gravel deposits are present, consideration should be given to developing wells in them rather than in the underlying bedrock. Wells in sand and gravel may have one or more of the following advantages over bedrock wells, particularly deep bedrock wells: shallower water levels, colder water, greater water yields to specific wells, and water of better mineral quality. The disadvantage of wells in sand and gravel is the special construction needed to take full advantage of the water-yielding capacity of the aquifer.

High-capacity sand and gravel wells require the use of screens which allow sand-free water to flow into the well bore. It is important in developing such wells to choose the size of the screen openings or slots on the basis of the size of the material to be screened. Therefore it is necessary to obtain samples of the aquifer and analyze its particle size in order to select the correct screen size.

Development necessarily follows construction of a sand and gravel well. In proper development, the finer grained materials in the immediate vicinity of the well bore are drawn through the screen and removed, leaving a natural graded filter that prevents pumping of sand and silt. Good results and yields are usually obtained from sand and gravel deposits by placing an "envelope" or "pack" of selected gravel or coarse sand between the deposit and the screen. The grain size of the particles in the gravel pack must have the proper relationship to the grain size and sorting of the formation and to the screen slot size to achieve the best results (Smith, H. F.: Gravel Packing Water Wells, Illinois State Water Survey Circular 44).

The use of slotted pipe or open pipe filled with gravel should be avoided except in very coarse deposits where the well will yield far more water than is pumped.

The physical characteristics of sand and gravel deposits are generally more variable than those of bedrock formations. For this reason, development of a well in sand and gravel usually requires test drilling before the well is designed and constructed. In areas where the presence of suitable aquifers is uncertain, a test drilling program is necessary to determine whether suitable deposits are present and, if they are, the best location for the well. Electrical earth resistivity surveys frequently are useful in determining the general area where test drilling might be undertaken.

Test holes are generally small-diameter holes drilled with cable tool (percussion) or with rotary equipment. The test driller's report is an important part of the groundwater development program and should include the following information when obtainable: 1) driller's log of formations penetrated; 2) static water level and changes in water levels during drilling; 3) drilling time of the individual formations; 4) weight and viscosity of drilling mud; and 5) loss of mud or fluid during drilling. Samples of drill cuttings should be saved at five-foot intervals and at changes in the formation.

Driving a sand point is the quickest and most economical method of well construction, but is practical only where small supplies of groundwater are needed and where such supplies are available from sand and gravel at shallow depth. Conditions suitable for driven wells exist in the Illinois and Sangamon Valley bottoms and locally in the sandy area in Menard, Macon, and Tazewell counties.

Large-diameter dug wells are most suitable in areas where the unconsolidated materials are fine-grained and cannot yield water readily to a drilled or driven well. They are used widely throughout much of the area in which glacial material is thin, tight, and underlain by relatively impermeable Pennsylvanian rocks. Large-diameter wells are excavated by hand only to shallow depths but may be excavated to as deep as 100 feet by power auger, shovel, or bucket.

In areas in which conditions are favorable for drilled or driven wells, the use of large-diameter dug wells is not recommended because of pollution and maintenance problems. The chief advantage of a large-diameter well is that it can store relatively large quantities of water. Short, intermittent pumping of a large-diameter well does not require immediate release of water from the surrounding materials, and the well can refill slowly between times of pumping. Special sanitary precautions should be taken with large-diameter wells (Circular 14A, Illinois State Department of Public Health, Springfield).

Bedrock Formations

Wells constructed in bedrock aquifers are less difficult to design than wells in unconsolidated material because the well bore generally is left uncased and little or no development is required. Test drilling is seldom done in bedrock aquifers, particularly if records of prior drilling in the area are available.

In east-central Illinois, geologic factors in well construction in bedrock aquifers are: 1) type, thickness, depth, and permeability of aquifers; 2) tendency of formations to sustain open hole without casing or lining; and 3) tendency of formations to yield silt or sand during pumping. Creviced dolomite and limestone do not normally require casing or lining. However, where groundwater supplies are obtained from dolomite or limestone with less than about 35 feet of overburden, there is danger of bacterial pollution. The open crevices provide little filtering or other purifying action, and polluted water may travel long distances through these openings.

In developing bedrock aquifers the driller commonly installs surface casing to firm bedrock and continues into the bedrock with an open hole. Where bedrock formations are too weak to sustain an open hole, it may be necessary to continue the surface casing through the weak formation into a more competent underlying formation or to set liners opposite the weak formations. Pennsylvanian shales (fig. 4) generally require casing. Conditions for drilled wells in the bedrock in east-central Illinois are locally favorable.

The main aquifers are the Silurian dolomite in the northeastern part of the area and shallow Pennsylvanian sandstones (fig. 7). Because the Pennsylvanian sandstones vary laterally in permeability they are not water-yielding at all sites. Water-pressure fracturing of Pennsylvanian sandstones has, in some instances, increased the initial yields of some wells. In areas where the unconsolidated material does not contain water-yielding sand and gravel deposits (fig. 6) and sandstones are absent,there are slight possibilities of obtaining small groundwater supplies from fractured shales, limestone, or coal.

Large Groundwater Supplies

Development of groundwater supplies for municipal, industrial, and irrigation purposes requires technical advice and careful planning based on all available geologic, geophysical, and hydrologic data. The type, extent, thickness, depth, distribution, and water-yielding characteristics of aquifers should be determined in order to estimate the available quantity of water and plan proper well construction. Hydrologic data, such as yields from existing wells, pressure potential of various formations, and water quality should be determined as accurately as possible.

Domestic Groundwater Supplies

Development of groundwater supplies for domestic and stock use differ from municipal, industrial, and irrigation developments in three important aspects: 1) the quantity of water needed for domestic and stock purposes is considerably smaller and may, therefore, be provided from considerably thinner and less permeable aquifers; 2) the area within which a well can be constructed for domestic or stock purposes is normally small, usually a farmyard or a suburban lot; and 3) the cost of well construction must be low.

In south-central Illinois geologic conditions are not always favorable for obtaining private water supplies with drilled wells. In areas of thin drift underlain by non-water-yielding bedrock (figs. 6, 7), dug wells are the most economical way of obtaining groundwater supplies.

Subsurface geologic conditions generally vary little within the limited area of an individual homesite or farm. However, there may be great changes in geologic conditions with increasing depth. Information on depth of aquifers is valuable for planning the type, depth, and size of the intended well.

Perhaps the most important considerations in locating private wells are those of sanitation and convenience. Wells should be placed with regard to geologic conditions, surface drainage, topography, and land usage so as to provide maximum protection from harmful bacteria and other objectionable inorganic material.

The following suggestions may be helpful in planning for individual or farm supplies:

1) Inventory the water requirements by estimating the amount of water needed for domestic use, stock use, milk cooling, cleaning, and fire protection.

2) Obtain all available information on the occurrence of water-yielding formations at the location. The maps in this report are designed to give a fundamental understanding of the occurrence and distribution of the water-yielding formations in this area, so that the most suitable type of well can be planned. If additional, more specific information is desired, address the Illinois State Geological Survey, Urbana, Illinois, giving: a) location of property by section, township, and range; b) intended use of the water supply; c) estimate of the quantity of water needed; and d) all information on existing wells on the property or on previous drilling attempts.

3) Select a well driller with a reputation for constructing wells that have been proved to be trouble-free. Make sure the driller is capable of properly handling the types of aquifers he may encounter at the location. If the well is to be finished in sand and gravel, select a driller experienced in setting well screens.

4) Check with the State Department of Public Health for regulations and suggestions on proper well construction and location and proper pump housing. The State Department of Public Health discourages the use of well pits on Grade A milk farms unless they are built to very rigid specifications. Properly constructed well pits are more expensive than other approved methods of pump installation.

5) Make periodic bacterial analyses of the water supply. Dug wells are more difficult to keep sanitary than are properly constructed drilled wells. Wells drilled into creviced dolomite and limestone formations are, however, also susceptible to bacterial pollution, particularly where the creviced formation is overlain by thin overburden.

Role of the Drilling Contractor

Much of the success of any drilled well depends on the skill and knowledge of the drilling contractor. A drilling contractor has certain duties and responsibilities to his customers:

1) The driller should provide an accurate log of the boring when the hole is completed. The log should include a description of the formations, information on the static water level, basic construction features of the well (length and size of well casing and screen, etc.), and an indication of the capacity of the well as determined by a pumping test. Copies of the driller's log should be filed with the Illinois State Geological Survey in Urbana. Log books may be obtained by drillers without charge from the Survey.

2) The well should be constructed in accordance with accepted safe sanitary practices. The top of the well should be constructed to prevent surface pollution from entering the well or seeping downward around the casing. It is also desirable that well construction allow for measurement of the depth to water without requiring removal of the pumping equipment.

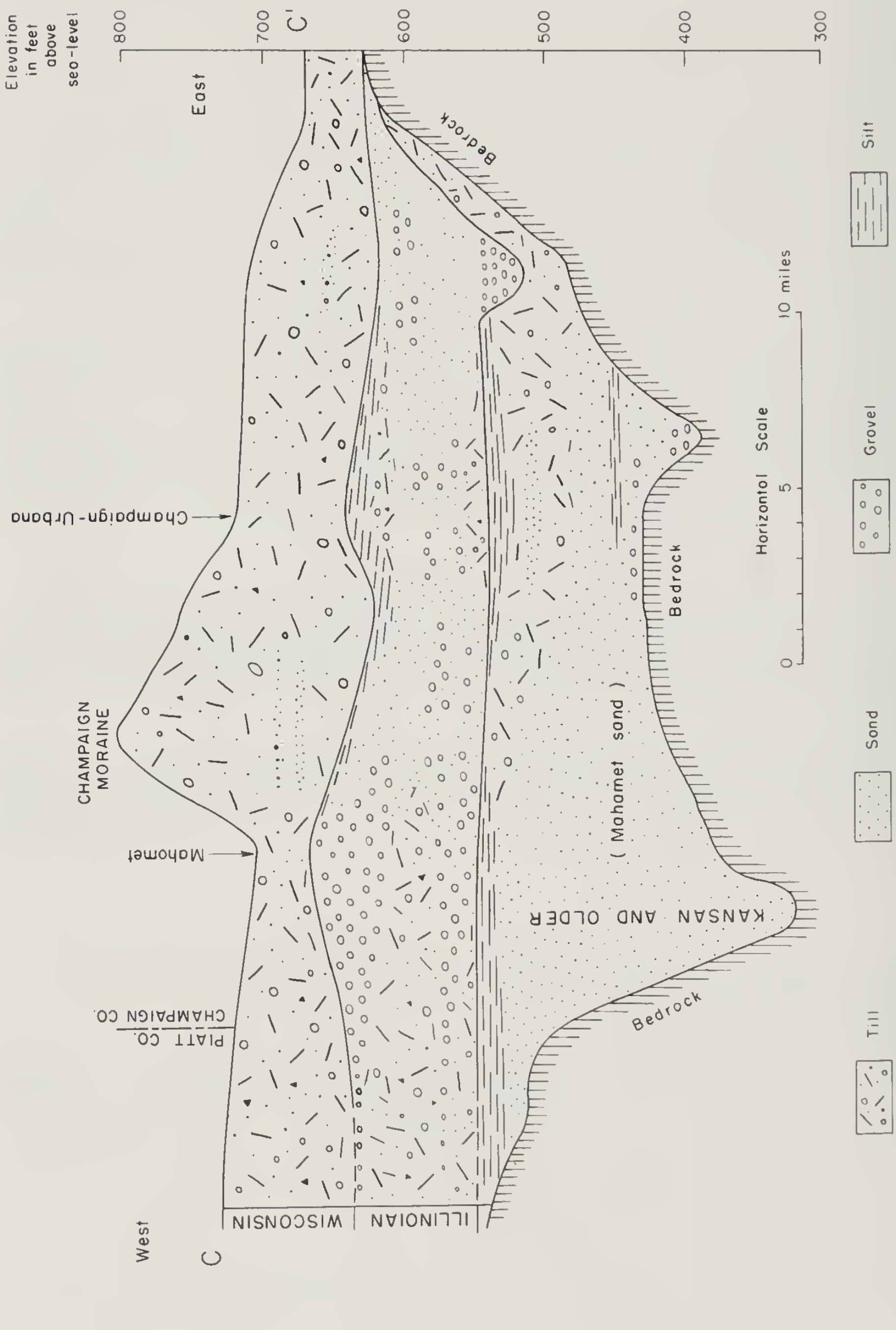


Fig. 8. - Cross section of Mahomet Valley in east-central Illinois.

3) The driller should endeavor to take full advantage of any water-yielding formations he may encounter. In areas where groundwater conditions are generally unfavorable, it takes a skillful driller to obtain the maximum amount of water from a poor formation. Where sand and gravel aquifers are used as a source of groundwater, the driller should select a well screen on the basis of size and sorting of the formation material. After construction the well should be properly developed. A properly screened and developed well in sand and gravel will not pump an objectionable amount of sand or silt during service.

4) It is desirable to save samples at 5-foot intervals for the total depth of drilling, especially for municipal, industrial irrigation, and school wells. The Illinois Geological Survey files samples of drill cuttings received from drillers. The samples may be sent express collect to the Survey where they will be studied and kept on file for reference. Information obtained from samples is vital in effective rehabilitation of old wells.

COUNTY GROUNDWATER SUMMARIES

Detailed information on groundwater supplies in the counties of east-central Illinois is given in the following pages. These discussions supplement the geologic information shown in figures 6 and 7.

Champaign County

In Champaign County the fill of the Mahomet Valley (figs. 3, 6, 8) contains sand and gravel deposits suitable for development of high-capacity wells. These sand and gravel deposits are generally concentrated in three zones: at depths between 60 and 120 feet, depths between 140 and 170 feet, and below a depth of approximately 200 feet. A typical log (Village of Mahomet test hole no. 1 in sec. 15, T. 20 N., R. 7 E.) follows:

Description	Thickness (ft.)	Depth (ft.)
Soil and till	55	55
Sand and gravel clean	68	123
Till	27	150
Sand, some gravel, clean	5	155
Till	25	180
Gravel, sandy, very silty	10	190
Sand and gravel	30	220

At some locations the zones of sand and gravel are nearly continuous vertically and extend from shallow depths to the top of the bedrock.

Municipal wells for Champaign-Urbana and the Petro Chemical wells located in Ts. 19 and 20 N., R. 8 E., are finished in the lower zone below 200 feet. The Northern Illinois Water Corporation well 52 (Champaign-Urbana water supply) is screened from $238\frac{1}{2}$ feet to $313\frac{1}{2}$ feet. The Illinois State Water Survey reports that in a pumping test conducted September 21, 1956, well 52 yielded 1940 gallons per minute with 9.55 feet of drawdown. Shallow deposits above a depth of 120 feet supply groundwater to many domestic and farm wells in the area; however, at many locations the shallow sand is very fine grained so that careful well development is needed.

In other parts of the county the glacial drift is generally more than 150 feet thick and contains sand and gravel deposits suitable for domestic and farm supplies. Locally municipal supplies have been obtained at Tolono, Pesotum, and Philo. In the southeastern part of the county, sand and gravel deposits are locally absent. Intensive test drilling was needed to locate the water supply for Broadlands and Longview.

The bedrock may contain water-yielding formations (figs. 4, 7) but, because groundwater supplies are usually available from the unconsolidated material, water wells rarely penetrate the bedrock.

Christian County

Groundwater probabilities in Christian County range from poor to good (fig. 6). Favorable conditions for industrial and municipal wells are found in a strip half a mile to two miles wide which extends from south of Harvel northeast through Morrisonville, Taylorville, and Stonington, on the east side of the Wabash railroad. In this area deposits of water-yielding sand and gravel are common below a depth of about 20 feet. The municipal wells for Taylorville and Stonington were finished at depths of 114 and 131 feet respectively. Some of the knolls and ridges present in Christian County contain water-yielding deposits of sand and gravel, but their value as sources of municipal or industrial groundwater supplies is restricted by the limited extent of the deposit.

Sand and gravel deposits are present in the Sangamon River flat and southward in the Mt. Auburn area. At Mt. Auburn a sand and gravel deposit 26 feet thick was encountered at a depth of 44 feet. Outwash deposits in minor stream valleys may yield small industrial and municipal groundwater supplies. Extensive testing, however, is commonly required to locate suitable sources of groundwater in the valley flats. Domestic and farm supplies are generally obtainable throughout Christian County except for an area south and west of Pana and in the western part of the county where the drift is thin. In this area, reported as "poor" in figure 6, water is obtained locally from large diameter dug wells in the drift or from wells drilled into the bedrock.

Throughout the county the Pennsylvanian bedrock below the drift is composed principally of shale. Locally, sandstone lenses are present and may yield small water supplies. However, drilling into the bedrock should be considered only when a suitable groundwater source cannot be found in the glacial drift; and because of the poor quality of water present in deeper bedrock formations, drilling should not extend below an approximate depth of 200 to 250 feet below land surface.

Coles County

Sand and gravel deposits favorable for domestic and farm supplies are present throughout Coles County except for small areas where the drift is thin (fig. 6). These sand and gravel deposits occur at various depths ranging from 40 to 100 feet below land surface. In Ts. 11 N., 12 N., 13 N. and 14 N., Rs. 7 E. and 8 E., sand and gravel deposits are more continuous than in other parts of the county and at some places may be the source for small municipal and industrial supplies.

The Mattoon city wells in sec. 30, T. 12 N., R. 8 E., and in sec. 18, T. 11 N., R. 7 E., are finished at depths ranging from 40 to 70 feet. In the buried valley of the Embarrass River (fig. 6 area outlined by dashes), the drift is thick and locally may contain favorable sand and gravel deposits.

The Pennsylvanian sandstones, coals, or fractured shale and limestone are local sources of groundwater for small farm supplies throughout the county (figs. 4, 7). Because of the poor quality of the water in deeper bedrock formations, drilling generally should not extend below a depth of approximately 300 feet.

DeWitt County

In DeWitt County municipal and industrial groundwater supplies are available from sand and gravel deposits in the buried Mahomet Valley (figs. 3,6,8) where drift deposits as much as 400 feet thick are present. The City of Clinton wells are finished in these deposits at depths of 340 to 360 feet. Local, water-yielding bodies of sand and gravel are found in the upper 200 feet of drift.

Shallow sand and gravel deposits, which may yield large groundwater supplies, are present in the extreme southwestern corner of the county where they are associated with the outer edge of the Wisconsin drift border (fig. 6). These deposits directly underlie the surface south, west, and northwest of Kenney.

Groundwater supplies for farm and domestic use can generally be developed in shallow sand and gravel beds in the upper 200 feet of the drift throughout the county. In the northeastern part, conditions are less favorable because sand and gravel layers in the drift are more discontinuous, and locally there is difficulty in developing farm or domestic groundwater supplies.

The Pennsylvanian bedrock underlying the drift is not generally used as a source of groundwater in the county because the glacial drift contains more favorable aquifers. Nevertheless, small supplies of groundwater may be obtained from the upper 50 to 100 feet of the Pennsylvanian formations, but they should be tested only after all attempts to develop a well in the drift have failed.

Douglas County

Sand and gravel deposits favorable for development of domestic and farm groundwater supplies are generally scattered over Douglas County, but in the northwestern and central part of the County they occur somewhat more consistently. Here the drift is as much as 150 feet or more thick in the buried Pesotum Valley and in two minor tributary valleys. Small municipal groundwater supplies have been developed from sand and gravel at Arcola, Arthur, Atwood and Newman.

Pennsylvanian bedrock, consisting principally of shale, underlies the drift in most of the county and locally may yield small groundwater supplies from thin beds of sandstone or creviced limestone or from fractures in the shale. Along the LaSalle Anticlinal Belt (fig. 5, cross section A-A', and fig. 7), bedrock of the Mississippian and Devonian systems directly underlies the drift. In this area groundwater is obtained from the Devonian and underlying Silurian dolomites where drift supplies are not available. Where Mississippian shales underlie the drift, drilling must continue through the shale into the dolomite. Tuscola and Villa Grove obtain groundwater supplies from Silurian and Devonian rocks.

Summary Sample-Study Log of Tuscola Well No. 4,
SW$\frac{1}{4}$ NW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 34, T. 16 N., R. 8 E.

Description	Thickness (ft.)	Depth (ft.)
Pleistocene series		
Till, sand, and silt	135	135
Mississippian system		
Shale, some siltstone with thin sandstone bed at base	133	268
Devonian system		
Dolomite, some limestone and thin siltstone beds	154	422
Silurian system		
Dolomite	272	694

At Villa Grove, the municipal wells are finished at depths of 645 and 627 feet into reported Devonian sandstone; the wells penetrate both Pennsylvanian and Mississippian shale. A number of domestic and farm wells also obtain small groundwater supplies from the upper part of the Devonian and Silurian dolomites in this area. Deeper drilling is not recommended at sites which are more than a mile away from the area of outcrop of the Mississippian and Devonian formations (fig. 7).

Edgar County

Sand and gravel deposits favorable for domestic and farm supplies are present at many places in the western part of Edgar County. In the eastern part the drift is generally thin. Bedrock crops out at many places east of Paris. Small municipal water supplies have been obtained locally after intensive test drilling to locate favorable sand and gravel aquifers. The towns of Hume, Metcalf, Kansas and Vermilion obtain water supplies from wells finished in unconsolidated material at depths of 55, 93, 85 and 103 feet respectively.

Groundwater is obtained from shallow Pennsylvanian sandstone, creviced limestone, and shale in most of the county (fig. 7). Drilling should be extended into the upper 100 to 150 feet of Pennsylvanian bedrock if water is not obtained from shallow unconsolidated deposits.

Ford County

In Ford County municipal and industrial groundwater supplies are available from sand and gravel deposits in the fill of the buried Mahomet Valley (figs. 3,6,8). Sand and gravel beds in the fill generally occur at depths ranging from 130 to 170 feet below land surface and below a depth of 300 feet. Locally, however, sand and gravel are missing. At Paxton extensive test drilling was necessary to locate a favorable well site.

Shallow sand and gravel deposits are present in the southern part of the county near Gibson City. These deposits are a dependable source of groundwater for domestic and farm wells and may supply larger quantities locally. Gibson City obtains its water supply from wells finished at depths of 55 to 58 feet. The fill of the Chatsworth and Kempton Valleys (figs. 3, 6) may contain permeable deposits suitable for small municipal and industrial supplies, but little is known about them.

Domestic and farm supplies are generally available from sand and gravel deposits throughout the rest of the county. Small municipal supplies have been obtained at Melvin, Piper City, Roberts, and Elliott. In Ts. 27, 28, 29 N., R. 9 E., drillers report that in places, sand and gravel beds are thin, and careful well construction and development are needed to obtain suitable water supplies.

Pennsylvanian bedrock underlies the drift in most of the county. Small groundwater supplies may be obtained locally from shallow Pennsylvanian formations and from Silurian and Devonian dolomite (figs. 4, 7).

Although the Illinois State Geological Survey does not have records of wells drilled into the St. Peter sandstone in this county, this formation may be a suitable source of groundwater north of Piper City where it is present at depths ranging from 900 to 1100 feet.

Iroquois County

The probabilities of obtaining industrial and municipal groundwater supplies from the unconsolidated glacial drift are excellent in much of Iroquois County (fig. 6). Sand and gravel deposits in the fill of the preglacial Mahomet and Onarga Valleys (fig. 3) are a source of water for the towns of Watseka, Onarga, Buckley, and Cissna Park. In the eastern part of the county, sand and gravel deposits are a good source of groundwater for domestic and farm supplies and locally for municipal supplies. The town of Sheldon obtains its water supply from sand and gravel at a depth of 116 feet. In the valley of Sugar Creek, sand and gravel deposits are present and locally are suitable for municipal supplies. Milford obtains its water supply from such deposits.

In the northern part of the county, Ts. 28 N. and 29 N., the drift is thinner, and sand and gravel deposits are scattered and discontinuous. Here most wells are finished in the upper 200 feet of Silurian and Devonian dolomites (figs. 4, 7).

Few wells have been drilled below the Kinderhook shale in the eastern part of the county. These are finished in dolomite at depths ranging from 200 to 300 feet below land surface.

The St. Peter sandstone may be a source of groundwater although the only available record of deep drilling in this area is the log of a municipal well drilled at Sheldon in 1898. This well was drilled to a depth of 1850 feet. State Water Survey Bulletin 40 reports that a 1918 water analysis shows a hardness of 1.4 gr. per gallon, a residue of 600 ppm, and an iron content of 0.1 ppm. The yield was reported to be 30 gpm.

Livingston County

Groundwater probabilities from sand and gravel aquifers are extremely variable in Livingston County. Although the drift is generally more than 100 feet thick throughout the county, it is composed mostly of till with only thin and discontinuous beds of sand and gravel. Locally the sand and gravel deposits are the source of small municipal groundwater supplies, as at Cornell, Cullom, Dwight, Flanagan, and Forrest, where water supplies are obtained from unconsolidated material within 150 feet of land surface.

Farm and domestic groundwater supplies are available from the drift in much of the county. Drillers report that in the area of thin drift around Odell (fig. 6), the probability of obtaining groundwater supplies is poor. At some locations in this area however, thin deposits of sand are locally present within the drift. Drillers report that with careful well construction and development small supplies of groundwater may be obtained from these sand deposits.

Throughout the county, domestic and farm supplies are obtained from shallow Pennsylvanian formations (fig. 7). Drilling into the Pennsylvanian is recommended only when a suitable groundwater supply is not obtained from the drift. Water in the Pennsylvanian bedrock is sometimes of poor quality as in the area around Odell where drillers report the water to be slightly salty.

In the northern and northeastern part of the county, the Silurian dolomite underlying the Pennsylvanian bedrock (fig. 7) is penetrated at depths ranging from 250 to 350 feet and is the chief source of water for many domestic and farm wells in the area. The dolomite thins to the northeast and is absent in most of the northern part of the county. To the south it contains water that is highly mineralized.

The St. Peter sandstone, which ranges in depth from 450 feet in the extreme northwestern corner of the county to 1400 feet at Fairbury, is considered a dependable aquifer by local well drillers. The formation has been the source of water to several municipalities in the county. Odell has a well finished in St. Peter sandstone at a depth of 1,341 feet. The analysis of a sample of water collected on May 4, 1947, shows a hardness of 8.7 gr. per gallon, a residue of 2389 ppm, and an iron content of 0.4 ppm. The town of Chatsworth has a well finished in St. Peter sandstone at a depth of 1285 feet. The analysis of a sample collected in May 1947 showed a hardness of 417 ppm, a residue of 699 ppm, and a chloride content of 2.0 ppm (State Water Survey Bull. 40).

Logan County

Domestic and farm groundwater supplies can be obtained from sand and gravel deposits in Logan County, in the area east and south of New Holland (fig. 6), and locally in the southern and eastern parts of the county where the drift is thin.

Municipal and industrial supplies can be obtained from the fill of the buried Mahomet Valley and locally from scattered sand and gravel deposits in the buried Middletown Valley (figs. 3, 6). The villages of Atlanta, Emden, and Hartsburg withdraw water from wells reaching depths between 97 and 191 feet in the Mahomet Valley fill. Middletown and possibly Elkhart City take water from wells 155 and 76 feet deep in the Middletown Valley fill.

In the remainder of the county, municipal groundwater supplies are locally available from sand and gravel and have been developed at Latham and Mt. Pulaski. Lincoln obtains a large groundwater supply from sand and gravel deposits in Salt Creek, and it is likely that sand and gravel deposits suitable for the development of large groundwater supplies may be present in other parts of Salt Creek as well as in Deer, Kickapoo, and Sugar creeks.

Domestic and farm supplies are obtained locally in the central and southern part of the county from the Pennsylvanian bedrock (fig. 7). Wells should not be drilled deeper than 150 to 200 feet into the bedrock.

Macon County

Conditions are favorable for obtaining municipal and industrial groundwater supplies in the northern part of Macon County (fig. 6). Here the buried

Mahomet Valley, which is filled with unconsolidated glacial drift material about 250 to 280 feet thick, contains thick water-yielding sand and gravel deposits. These deposits are present at various depths but generally occur between depths of 70 to 90 feet and below a depth of 200 feet. The town of Maroa obtains its groundwater supply from sand and gravel deposits at a depth of 81 feet. At Argenta a well was finished in sand at a depth of 233 feet. The alluvial deposits along the Sangamon River are also a possible source for municipal and industrial supplies.

Domestic, farm, and, locally, larger supplies are available throughout the county. Shallow gravel deposits at the front of the Wisconsin glacial border (fig. 3) are a favorable source of groundwater west of Macon, Harristown,and Warrensburg. Drillers report the area between Blue Mound and the Sangamon River to be less favorable. The municipal supply for Niantic is obtained from a well drilled to a depth of 48 feet. Thicker drift behind the border of the Wisconsin glaciation contains sand and gravel beds which locally are favorable sources of groundwater.

The Pennsylvanian bedrock below the glacial drift is composed principally of shale with thin beds of limestone, sandstone, and coal. Because of the widespread availability of groundwater from sand and gravel, wells drilled into the bedrock are uncommon in most of the county. In the southern part of the county, in Ts. 15 N. and 14 N., if water is not obtained from shallow drift deposits, wells should be drilled to the upper 50 to 100 feet of bedrock where small supplies may be obtained from water-yielding sandstone or creviced limestone or shale. Deeper drilling is not recommended because the water in deeper bedrock formations is highly mineralized.

Marshall County

In Marshall County extensive thick permeable sand and gravel deposits occur along the Illinois River Valley and extend several miles eastward from the river (fig. 6). In this area the Sankoty sand forms the base of the glacial deposits. Along the Illinois River Valley the Sankoty sand is overlain by glacial outwash and later alluvial deposits, but outside the valley it is overlain by till. Municipal and industrial groundwater supplies can generally be obtained from the Sankoty sand. The shallower sand and gravel outwash is also a dependable source of groundwater in the valley. A small, buried bedrock valley in the southwestern corner of the county (fig. 6) is recognized, but not enough information is available to forecast the water-yielding potential of the valley fill.

In the eastern and western parts of Marshall County, average thickness of the drift is 75 to 100 feet. In these areas domestic and farm supplies can generally be obtained from thin scattered layers of sand and gravel within the drift.

The Pennsylvanian formations underlying the drift in the eastern and western parts of the county are not considered a dependable source of groundwater. Small groundwater supplies are available from a few wells in the Pennsylvanian rocks, but drilling into these formations should be considered only as a last resort.

The villages of Toluca and Wenona obtain their water supply from the St. Peter sandstone at depths of 2000 and 1855 feet respectively. The State Water Survey reports that the water is highly mineralized at both villages: 1080 ppm chloride, 200 ppm hardness, and a residue of 2322 ppm at Toluca; 490 ppm chloride, 256 ppm hardness, and a residue of 1437 ppm at Wenona.

Mason County

Geologic conditions in Mason County and adjoining parts of Tazewell and Logan counties are favorable for developing large groundwater supplies. This area is a wide, bedrock lowland that was formed at the confluence of the ancient Mississippi and Mahomet rivers and is now buried beneath a thick mantle of glacial deposits, mainly sand and gravel. The deposits include ancient stream fills and later glacial outwash that poured down the Illinois River Valley. Around Havana the deposits have an average thickness of about 150 to 200 feet and are composed of sand and gravel in the upper part, and mainly of sand in the lower part.

The following sequence, penetrated one and a half miles south of Forest City in sec. 19, T. 22 N., R. 6 W., is representative of the valley fill in the lowland area.

Description	Thickness (ft.)	Depth (ft.)
Sand fine to medium, some coarse sand at base	50	50
Sand fine to medium	40	90
Sand fine to medium, silty	30	120
Sand fine to medium, some granular gravel, very silty	10	130
Sand, fine to medium	10	140
Shale, dark grey	10	150

Most of the wells in the lowland area are finished in shallow aquifers at depths ranging from 40 to 120 feet below land surface. Wells drilled for the city of Havana are finished at depths ranging from 70 to 90 feet. Domestic and farm supplies are easily obtainable at depths of less than 50 feet with sand points, drilled, and dug wells.

In the upland areas in the southeastern part of the county, the lower sand and gravel deposits are overlain by glacial till. This sequence of unconsolidated material offers several water-yielding horizons. Sand and gravel lenses that vary laterally in extent, thickness, and permeability are sources of water for many private supplies. As in the lowland area the sand and gravel in the deeper part of the unconsolidated material is a dependable source of groundwater. The following is a sequence of deposits encountered in drilling at Mason City in sec. 8, T. 20 N., R. 5 W.:

Description	Thickness (ft.)	Depth (ft.)
Soil	5	5
Sand, fine	35	40
Silt	5	45
Till, silty, brown	5	50
Sand, medium to coarse	5	55
Sand, very coarse, some gravel, dirty	10	65
Till, yellowish, brown	20	85
Sand, fine to medium	5	90
Sample missing	105	195
Sand, very fine to fine	4	199
Sand, very coarse, some gravel	11	210
Sand, medium to coarse	10	220

The well was finished at 220 feet, but sand is present below this depth and extends to bedrock. Municipal and industrial supply may be obtained from the lower sand at most locations in this upland area.

Mississippian and Pennsylvanian bedrock formations underlie the glacial drift (fig. 7); but because groundwater is available in shallow unconsolidated material, only a few water wells have been attempted in the bedrock.

McLean County

Sand and gravel deposits suitable for the development of high-capacity wells are present in the buried Mahomet Valley in the southwestern part of McLean County (figs. 3, 6). The village of McLean obtains water from these deposits at a depth of 353 feet. Favorable conditions for the construction of municipal and industrial wells are also found locally along the ridge-like features (moraines) that cross the county. Thicker drift associated with the moraines contains sand and gravel deposits which are the source of water for the towns of LeRoy, Normal, Saybrook, and Lexington. Small stream valleys, such as portions of Sugar Creek Valley, occasionally contain sufficient deposits of sand and gravel for small municipal and industrial supplies. In most instances, however, extensive test drilling is necessary to locate the most suitable sites for well locations.

Farm and domestic supplies are available throughout most of the county. Because conditions within the drift are so variable, it is advisable to test the entire thickness of drift because water-yielding deposits are commonly present at shallow depths and at the base of the drift just above the bedrock.

The Pennsylvanian bedrock directly underlies the glacial drift throughout the county. Although little information is available on the distribution of water-yielding beds within the upper part of the Pennsylvanian rocks, a few wells obtain small supplies of groundwater from these formations. When all attempts to develop drift wells have failed, the upper 100 feet of the Pennsylvanian bedrock should be tested for the presence of water-yielding sandstone, creviced limestone, or fractured shale beds. Below 100 feet in the bedrock the formations are generally tight and the water is highly mineralized.

In the northeastern-most portions of the county it is likely that deeper bedrock formations may yield large groundwater supplies. The village of Chenoa has a well finished in the Oneota formation (fig. 4) at a depth of 2035 feet. However, the State Water Survey (Bull. 40) reports that the mineral content of the water is high, with a residue of 1314 ppm, a chloride content of 540 ppm and a hardness of 229 ppm.

Menard County

Unconsolidated deposits, locally as much as 150 feet thick, are associated with the buried Ancient Mississippi Valley, the Sangamon River, and Salt Creek in the extreme northern part of Menard County. These deposits contain beds of sand and gravel favorable for the development of small industrial or municipal groundwater supplies. The buried Athens Valley (figs. 3, 6) also may contain as much as 150 feet of glacial drift, but little is known about the distribution of water-yielding sand and gravel within the fill.

Sand and gravel outwash deposits along the Sangamon River in the southern part of the county are generally thin and patchy, and bedrock crops out along the valley. From Petersburg north, the valley fill thickens somewhat and may contain more continuous deposits of sand and gravel. The water supply for Petersburg is taken from these sand and gravel deposits.

Sand and gravel deposits are generally thin and discontinuous on the uplands. Locally these deposits are the source of groundwater for domestic and farm supplies.

Pennsylvanian bedrock underlying the drift throughout the county is locally a source of groundwater for domestic and farm supplies.

Moultrie County

Municipal and industrial supplies may be obtained locally in the flat of the Kaskaskia River, its tributaries, and in the fill of the preglacial Middletown valley which extends from south of Sullivan to the northwest corner of Moultrie County (fig. 3).

The glacial fill of the Middletown valley ranges in thickness from 150 to 200 feet. At many locations, according to drillers, the fill is composed principally of clay but locally contains sand and gravel deposits which may be a source of groundwater for industrial and municipal supplies. Testing is needed to locate suitable sand and gravel deposits in the Middletown valley area. The "North well" of the town of Sullivan drilled in the northeast corner of sec. 23, T. 13 N., R. 5 E., penetrates the following deposits:

Description	Thickness (ft.)	Depth (ft.)
Pleistocene series		
Clay	64	64
Sand and gravel	37	101
Hardpan	3	104
Gravel	3	107
Clay and gravel	22	129

A well at Dalton City is finished in gravel at a depth of 108 feet.

Throughout most of the county, water for farm and domestic supplies is obtained from thin sand and gravel deposits within the drift. Locally in Ts. 13 N., 14 N. and 15 N., R. 6 E., sand and gravel are absent, and wells have been drilled into the Pennsylvanian bedrock.

Pennsylvanian sandstones, coal, or fractured shales and limestone are a local source of water for small farm supplies. Because of the poor quality of water in deeper bedrock formations, drilling should not extend below a depth of approximately 300 feet.

Piatt County

In Piatt County excellent water-yielding sand and gravel deposits suitable for municipal and industrial supplies occur in the fill of the buried Mahomet Valley (figs. 3, 6, 8). The following sequence of deposits was penetrated at Monticello, sec. 7, T. 18 N., R. 6 E:

Description	Thickness (ft.)	Depth (ft.)
Soil and till	28	28
Sand and gravel	12	40
Till	55	95
Sand and fine gravel	15	110
Sand, some clay and gravel	40	150
Sand	15	165
Sand with organic matter	5	170
Sand	5	175
Gravel	34	209

The city of Decatur has wells in sec. 30, T. 18 N., R. 5 E., finished in sand at a depth of 256 feet.

The buried Pesotum Valley (fig. 3 and area outlined by dashes in fig. 6) locally may contain sand and gravel deposits favorable for industrial and municipal supplies and appears worthy of testing.

Sand and gravel deposits suitable for domestic and farm supplies generally occur throughout the county at depths ranging from 80 to 200 feet. Locally small municipal supplies may be developed in these deposits. For example, the Hammond municipal supply is obtained from sand at a depth of 143 feet. Drillers report that north of Deland, sand and gravel beds are generally thin and discontinuous.

Because of the availability of water from sand and gravel above the bedrock, wells are rarely drilled into shallow Pennsylvanian bedrock formations (fig. 7). It is possible that locally small farm supplies may be obtained in the upper 250 to 300 feet of bedrock.

Putnam County

In Putnam County excellent water-yielding sand and gravel deposits suitable for high-capacity wells occur in the fill of the buried Ancient Mississippi Valley and locally in the buried Ticona Valley (figs. 3, 6). Domestic and farm supplies are available throughout the county from thin layers of sand and gravel within the drift.

Pennsylvanian sandstones or fractured limestones are local sources of water for small farm supplies throughout the county (fig. 7).

In the eastern two-thirds of the county, Silurian and Devonian limestone and dolomite below the Pennsylvanian rocks may be a source of groundwater. These formations occur at depths generally greater than 400 feet below land surface. The village of Hennepin obtains its groundwater supply from limestone at depths of 400 to 850 feet. Little information is available on the groundwater potential of these formations in Putnam County.

The Ordovician-St. Peter sandstone (fig. 4) is the only major deep bedrock aquifer being utilized in Putnam County. At present the villages of Granville and Standard have wells finished in this formation. At Granville the St. Peter sandstone was penetrated at a depth of 1635 feet below land surface. According to the State Water Survey, water obtained from this well had a hardness of 296 ppm, a residue of 994 ppm, a chloride content of 305 ppm, and an iron content of 1.7 ppm. At Standard, the St. Peter sandstone was penetrated at a depth of 1600 feet and the water had a hardness of 237 ppm, a residue of

3279 ppm, a chloride content of 1675 ppm, and an iron content of 2.2 ppm. (Illinois Water Survey Bull. 40, 1948).

Sangamon County

Except for a narrow band along the Sangamon River, the probabilities of obtaining municipal or industrial groundwater supplies in Sangamon County are generally poor. Near Springfield and extending southward in T. 14 N. (fig. 6), the unconsolidated glacial drift is thin and composed of compact clay. In this area groundwater supplies are generally obtained with large diameter dug wells or with drilled wells penetrating the upper part of the underlying Pennsylvanian bedrock.

In the rest of the county the unconsolidated glacial drift ranges in thickness from 50 feet to 130 feet; and sand deposits suitable for the construction of farm and domestic wells have been encountered at depths ranging from 60 to 130 feet below land surface in T. 13 N. and T. 14 N., R. 7 W. and R. 6 W. and in the area of Buffalo and Mechanicsburg. Drillers in the area report that careful well construction and development is necessary to utilize these deposits which are generally thin and fine. Lack of information on water wells in the county make it impossible to evaluate accurately the extent and continuity of water-yielding sand in the drift. The fill of the buried Athens Valley (fig. 3) contains favorable sand and gravel deposits locally. Little is known, however, of the character of the valley fill in Sangamon County.

The Pennsylvanian bedrock below the glacial drift is composed of shale with beds of limestone, sandstone and coal. Throughout the county small groundwater supplies have been obtained from permeable sandstone, creviced limestone, or fractured shale in the upper 150 feet of bedrock. Drilling should not extend below this depth because mineralized water is usually encountered in the deeper bedrock formations.

Tazewell County

The probability of obtaining industrial and municipal supplies from the unconsolidated material is excellent in most of Tazewell County. The area is part of a wide, bedrock lowland formed at the confluence of the ancient Mississippi and Mahomet Rivers and buried beneath thick unconsolidated deposits of mainly sand and gravel. These deposits include stream fills and glacial outwash that poured down the Illinois River Valley. They are generally composed of sand and gravel in the upper part and sand in the lower part. The city of Pekin obtains its water supply from shallow sand and gravel at a depth of 119 feet. Domestic and farm supplies are easily obtainable at depths less than 50 feet with driven sand points or with drilled and dug wells, with the exception of a small area east of Pekin (fig. 6) where the unconsolidated material is thin.

In the upland area in the east half of the county, the lower sand and gravel deposits are overlain by glacial till. Interbedded with the till are sand and gravel beds that are sources of water for many private supplies and locally for small municipal supply. The Tremont water supply is obtained from wells finished in sand and gravel at depths of 133 and 154 feet. As in the lowland area, the sand and gravel in the deeper part of the unconsolidated material is a dependable source of groundwater. The following log of the city of Washington Well No. 3 shows the sequence of material generally encountered in the upland area:

Description	Thickness (ft.)	Depth (ft.)
Pleistocene series		
Soil, silt, till	83	83
Gravel	11	94
Till	69	163
Gravel	10	173
Silt and till	27	200
Gravel	18	218
Till	32	250
Sand and gravel	120	370
Pennsylvanian system		
Siltstone	5	375

The Pennsylvanian bedrock (fig. 7) below the drift is a source of water for farm and domestic supplies east of Pekin where the drift is thin. In the rest of the county, because groundwater is widely available from the unconsolidated material, only a few wells have been attempted in the bedrock.

Vermilion County

In Vermilion County dependable water-yielding sand and gravel deposits occur at many places in the fill of the Mahomet bedrock valley and its southern tributaries (figs. 3, 6). The thickness of the drift in the valley ranges from about 250 to 350 feet and contains several zones of water-yielding sand and gravel. Although these beds are encountered at various depths within the drift, they are more continuous and usually occur at depths ranging from 80 to 140 feet and below a depth of about 200 feet.

The towns of Hoopeston, Potomac, Rossville, and Rankin obtain water supplies from sand and gravel deposits encountered at depths ranging from 110 to 230 feet. The water present in the drift is confined at most places, and drillers refer to this area as the "artesian belt". Favorable conditions for developing groundwater supplies from sand and gravel are locally present along the North Fork of the Vermilion River.

A belt of thick drift in the Danville area is probably associated with the channel of a preglacial bedrock valley (fig. 3). The area is worth testing to locate suitable water-yielding deposits for small industrial supplies. In the area of Allerton, Sidell, and Indianola, sand and gravel beds are absent locally, and sometimes test drilling is required to locate a favorable well site. The thickness of the drift ranges from about 60-120 feet in the south to about 80-200 feet in the north.

In the other parts of the county, the probability of obtaining groundwater supplies from the drift is fair. Sand and gravel deposits suitable for domestic and farm wells are generally present, and locally, especially east of Rossville, they may yield water for small industrial and municipal supplies.

South of Danville the probabilities of aquifers above the bedrock are poor. Here, some wells that have penetrated the upper part of the Pennsylvanian bedrock obtain small supplies of groundwater from shale and thin sandstone or limestone beds. With the exception of the areas shown as "poor" in figure 6, every effort should be made to develop a well in the drift before drilling into the bedrock. The quality of the water obtained from the bedrock formations below depths ranging from 150 to 300 feet may be unsatisfactory.

Woodford County

The Sankoty sand occurs at the base of the drift in the western part of Woodford County. This formation and the outwash sand and gravel deposits in the Illinois River Valley are sources of municipal and industrial groundwater supply (fig. 6). In the remainder of the county, large supplies may be obtained locally, although extensive test drilling is usually necessary to locate the best well sites.

Groundwater supplies for farm and domestic use are generally available from sand or gravel layers within the drift, and therefore relatively few wells are finished in the Pennsylvanian formations (figs. 5, 7). In the eastern two-thirds of the county, if water is not obtained from the unconsolidated material, the upper part of the Pennsylvanian bedrock should be tested.

Two wells for the city of Minonk have been finished in the St. Peter sandstone (fig. 5). Water from the first well, drilled in 1893 to a depth of 1850 feet, was reported to have a hardness of 239 ppm, a chloride content of 685 ppm, and a residue of 1703 ppm (State Water Survey Bull. 40). Throughout the remainder of the county, the deeper bedrock formations appear to contain water too highly mineralized for ordinary use.

SUGGESTED READING

An Intregrated Geophysical and Geological Investigation of Aquifers in Glacial Drift near Champaign-Urbana, Illinois: John W. Foster and Merlyn B. Buhle, Illinois Geol. Survey Rept. Inv. 155, 1951.

Bedrock topography of Illinois: Leland Horberg, Illinois Geol. Survey Bull. 73, 1950.

Cisterns: Illinois Dept. of Public Health Circ. 129, 1949.

Disinfection of water: Illinois Dept. of Public Health Circ. 97, 1950.

Groundwater in the Peoria region: Leland Horberg, T.E. Larson, and Max Suter, Illinois Geol. Survey Bull. 75 (Illinois Water Survey Bull. 39), 1950.

Geology and mineral resources of the Marseilles, Ottawa,and Streator quadrangles: H.B. Willman and J. Norman Payne, Illinois Geol. Survey Bull.66, 1942.

Geology and mineral resources of the Beardstown, Glasford, Havana, and Vermont Quadrangles: H. R. Wanless, Illinois Geol. Survey Bull. 82, 1957.

Individual water supply systems: Recommendation of the Joint Committee on Rural Sanitation: U. S. Public Health Service Pub. 24, 1950.

Major aquifers in glacial drift near Mattoon, Illinois: John W. Foster, Illinois Geol. Survey Circ. 179, 1952.

Pleistocene deposits below the Wisconsin Drift in northeastern Illinois: Leland Horberg, Illinois Geol. Survey Rept. Inv. 165, 1953.

Public ground-water supplies in Illinois: compiled by G.C. Habermeyer, Illinois Water Survey Bull. 21, 1925.

Public ground-water supplies in Illinois: compiled by Ross Hanson, Illinois Water Survey Bull. 40, 1950.

Significance of Pleistocene deposits in the groundwater resources of Illinois: J. W. Foster, Economic Geology, v. 48, no. 7, November 1953.

Wells, dug,drilled, driven: Illinois Dept. of Public Health Circ. 14, 1951.

Other general reports on groundwater geology in Illinois, similar in purpose and scope to the present study, include the following circulars: C 192, Water wells for farm supply in central and eastern Illinois; C 198, Groundwater possibilities in northeastern Illinois; C 207, Groundwater in northwestern Illinois; and C 212, Groundwater geology in southern Illinois; C 222, Groundwater geology in western Illinois, north part; C 225, Groundwater geology in south-central Illinois; C 232, Groundwater geology in western Illinois, south part. These circulars, published by the Illinois State Geological Survey, are available free on request.

Topographic maps are available for the area covered in this report. These maps are on a scale of approximately 1 inch to the mile, but in the Champaign-Urbana, Danville, East Peoria, Havana, and Springfield regions they are available also on a scale of approximately $2\frac{1}{2}$ inches to the mile. They are printed by quadrangle and may be obtained from the Illinois State Geological Survey, Urbana, Illinois, or from the United States Geological Survey, Washington 25, D. C., for 30 cents each. Index maps showing the topographic map coverage of the state are free on request.

Detailed geologic reports have been published for the following quadrangles: Danville, Hennepin, LaSalle, Peoria, Tallula, Springfield. Information on these reports may be obtained from the Illinois State Geological Survey, Urbana, Illinois.

Illinois State Geological Survey Circular 248
36 p., 7 figs., 1958

ILLINOIS

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CIRCULAR 248

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